(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
7 September 2001 (07.09.2001)

PCT

(10) International Publication Number
WO 01/65466 A2

(51) International Patent Classification[7]: G06K

(21) International Application Number: PCT/US01/06711

(22) International Filing Date: 28 February 2001 (28.02.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
09/515,249 29 February 2000 (29.02.2000) US

(71) Applicant *(for all designated States except US)*: **DIGITAL PERSONA, INC.** [US/US]; Suite 226, 805 Veterans Boulevard, Redwood City, CA 94063 (US).

(72) **Inventors; and**
(75) **Inventors/Applicants** *(for US only)*: **BROWNLEE, Kenneth** [US/US]; 3617 Louis Road, Palo Alto, CA 94303 (US). **MOK, Fai** [US/US]; 24230 Hillhurst Drive, West Hills, CA 91304 (US).

(74) **Agents: MALLIE, Michael, J.** et al.; Blakely, Sokoloff, Taylor & Zafman LLP, 7th floor, 12400 Wilshire Boulevard, Los Angeles, CA 90025 (US).

(81) **Designated States** *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) **Designated States** *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *without international search report and to be republished upon receipt of that report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

WO 01/65466 A2

(54) **Title:** METHOD AND APPARATUS FOR DETECTING A COLOR CHANGE OF A LIVE FINGER

(57) **Abstract:** A method and apparatus for distinguishing a human finger from a reproduction of a fingerprint. A finger is placed on a transparent platen having a prism or microprism array attached. A first light source directs light substantially orthogonal to the platen, where a first image of the fingerprint is captured by an imaging device. A second light source directs light at an acute angle to the platen, where a second image of the fingerprint is captured by the imaging device. A determination that the fingerprint is from a human finger is made if a mathematical comparison of the two images meets some predetermined criteria.

METHOD AND APPARATUS FOR DETECTING A COLOR CHANGE OF A LIVE FINGER

FIELD OF THE INVENTION

This invention relates generally to a fingerprint scanning system, and more particularly to a method and apparatus for distinguishing a human finger from a reproduction of a fingerprint.

BACKGROUND OF THE INVENTION

Automatic fingerprint scanners are commonly used to obtain an analog or digital image for security, access, verification, or record-keeping applications. In most conventional scanners, a two-dimensional (2D) image of the fingerprint is captured by an imaging device having a matrix of picture elements or pixels arranged as multiple rows and columns. A 2D light-sensitive electronic sensor, such as a charge-coupled device (CCD), is typically used to capture a fingerprint image.

Fingerprint imaging systems must determine if the image presented is a real finger or instead an optical or mechanical reproduction of a fingerprint. Such reproductions may be in the form of a fingerprint printed on paper, a fingerprint printed on clear or reflective plastic, or may be in the form of a three-dimensional (3D) model of a fingerprint, such as a rubber stamp. In the extreme case, a finger may be removed from its rightful owner and used with the imaging system without the rightful owner being present.

Therefore, there is a need for distinguishing a human finger from a reproduction of a fingerprint. There is a further need for distinguishing a live finger from a dead finger.

SUMMARY OF THE INVENTION

The present invention provides a method and apparatus for distinguishing a human finger from a reproduction of a fingerprint. A finger is placed on a transparent platen having a prism or microprism array attached. A first light source directs light substantially orthogonal to the platen, where a first image of the fingerprint is captured by an imaging device. A second light source

directs light at an acute angle to the platen, where a second image of the fingerprint is captured by the imaging device. A determination that the fingerprint is from a human finger is made if a mathematical comparison of the two images meets some predetermined criteria.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is illustrated by way of example and may be better understood by referring to the following description in conjunction with the accompanying drawings, in which like references indicate similar elements and in which:

FIG. 1 shows an embodiment of a fingerprint scanning system;

FIG. 2 shows another embodiment of a fingerprint scanning system;

FIG. 3 shows a side view of fingerprint ridges during scanning with a fingerprint scanning system;

FIG. 4 shows a planar view of the area of a fingerprint during scanning with a fingerprint scanning system;

FIG. 5 shows a top view of a platen having a raised portion;

FIG. 6 is a flowchart of a method for distinguishing a human finger from a reproduction of a fingerprint;

FIG. 7 shows a perspective view of a platen with horizontal illumination;

FIG. 8 shows a side view of a platen and finger with external illumination of the finger;

FIG. 9 is a flowchart of a method for distinguishing a human finger from a reproduction of a fingerprint using total internal reflection (TIR).

DETAILED DESCRIPTION

In the following description of a fingerprint scanning system, reference is made to the accompanying drawings which form a part hereof, and in which is shown by way of illustration a specific embodiment in which the invention may be practiced. It is to be understood that other embodiments may be utilized and structural changes may be made and changes to the mathematical algorithms

may be made without departing from the scope of the present invention. In one embodiment, described below, enables a remote computer system user to execute a software application on a network file server.

In the following description, for purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the disclosed technology. It will be evident, however, to one skilled in the art that the disclosed technology may be practiced without these specific details. In other instances, well-known structures and devices are shown in block diagram form in order to facilitate description.

A method and apparatus for distinguishing a human finger from a reproduction of a fingerprint is provided. A finger is placed on a transparent platen. A first light source directs light substantially orthogonal to the platen, where a first image of the fingerprint is captured by an imaging device. A second light source directs light at an acute angle to the platen, where a second image of the fingerprint is captured by the imaging device. A determination that the fingerprint is from a human finger is made if a comparison of the two images meets a predetermined criteria.

FIG. 1 shows an embodiment of the fingerprint scanning system. A finger **101** or palm is placed on a transparent platen **103** providing a surface for contact with the finger **101**. A first light source **105** directs light substantially orthogonal through the platen **103** to illuminate the finger **101**. A second light source **107** directs light at an oblique or acute angle to the platen **103**. An optional diffuser **109** may be placed between the second light source **107** and the platen **103** to diffuse the light from the second light source **107**. Light directed through or at the platen **103** is focused onto an electronic imaging device **113**. An optional focusing device **111** may be used to focus light onto the imaging device **113**. The platen **103** may preferably be glass or plastic, but it will be recognized by one of ordinary skill in the art that the platen **103** may be constructed of other materials so long as the platen **103** is substantially transparent to the wavelength(s) of light generated by the first light source **105** and second light source **107**.

Either the first light source **105** or the second light source **107** may preferably be one or more light emitting diodes (LEDs), but it will be recognized by one of ordinary skill in the art that other light sources may be used with the system, including ambient room light, without loss of generality. The focusing device **111** may preferably be a lens, but it will be recognized by one of ordinary skill in the art that other focusing devices, such as a fiber optic device or curved mirror, may be used without loss of generality. The imaging device **113** may preferably be a charge-coupled device (CCD), but it will be recognized by one of ordinary skill in the art that other imaging devices, such as a complementary metal-oxide semiconductor (CMOS) sensor or a contact image sensor (CIS), may be used without loss of generality. For yet another embodiment, a color imaging device may be used.

As shown in FIG. **1**, in one embodiment, the platen **103** may incorporate a bulk prism.. FIG. **2** shows another embodiment, in which the platen **203** incorporates a microprism. It will be recognized by one of ordinary skill in the art that other embodiments using variations in the optics may be used without loss of generality. For example, a direct light source **701** may be positioned to direct light horizontally into the platen or prism **703** as shown in FIG. 7. A direct light source **801** may also be positioned to as shown in FIG. **8** to illuminate the flesh of the fingertip **805** external to the platen or prism **803**. In this case, internal scattering of light by blood and skin cells yields a positive image through the platen or prism **803**. It will be recognized by one of ordinary skill in the art that additional or alternative lenses, mirrors, prisms, polarizers, diffractors or other optical elements may be inserted into the light path as needed in order to change focal lengths, improve image contrast, color or brightness, differentiate between materials presented on the platen or prism **803**, or otherwise accommodate a wide range of electronic imaging devices and light sources.

With the embodiments shown in FIG. **1** and FIG. 2, two different light sources are used. The first light source **105, 205** preferably illuminates a fingerprint directly, and the second light source **205, 207** preferably illuminates

the fingerprint using total internal reflection (TIR). The resulting images obtained using each light source individually, or by superimposing both, are different when a true finger is placed on the platen from a reproduction of a fingerprint. The light sources **105**, **107**, **205**, **207** may generate light of any color in the visible spectrum, or may also generate light or electromagnetic radiation in the infrared or ultraviolet spectrum.

With the system described above, a human finger typically yields a positive image under direct illumination and a negative image under TIR illumination. Positive is taken to mean that relatively more light is recorded in parts of the image where the raised finger ridges are in contact with the platen, and relatively less light is recorded in parts of the image corresponding to spaces between the finger ridges. Most reproductions of fingerprints typically do not yield such strongly reversed images under the two types of illumination.

The two light sources may be operated sequentially and electronic image processing used to measure the difference between the images. Alternatively, the two light sources may be operated simultaneously, in which the image of a true finger will tend to be canceled out, but the image of a reproduction of a fingerprint will tend to be reinforced. Simultaneous illumination with two light sources can typically distinguish a rubber stamp of a fingerprint because the level of reflectivity of the rubber material does necessarily match the reflectivity of human skin. In addition, simultaneous illumination may be used to determine the authenticity of other human body parts including, but not limited to, hands, feet, parts of the eye, and entire faces.

When a finger **101** is directly illuminated by light source **105**, which is when light inside the prism **103** is incident on the surface at less than the critical angle, the light exits the prism **103** to illuminate the surface of the finger **101**. In regions where the finger **101** is in contact with the prism **103** surface, a portion of the light is scattered back into the prism **103** at an angle greater than the critical angle. An imaging device **113** positioned at an angle greater than the critical angle to the prism can image a positive image of the fingerprint, where the

ridges of the fingerprint are light and the background or valleys of the fingerprint are dark.

Conversely, the prism **103** or **203** may be illuminated by light source **107** where much of the light is incident on the surface at greater than the critical angle, and therefore the light is totally internally reflected toward the electronic imaging device **113, 213**. The captured image will consequently be light in all areas except those where something is in contact with the TIR surface. If a finger **101, 201** is placed on the TIR surface, the imaging device **113, 213** can capture a negative image, where the ridges of the fingerprint are relatively dark and the background of the fingerprint is light.

A summary of several types of scanned images and their scan results are summarized in Table **1** below.

	TIR Light Source On	Direct Light Source On	TIR and Direct Light Sources On
Real Finger	Negative Image	Positive Image	All Areas Light
White Paper With Black Ridges	Positive Image	Positive Image	High Contrast Positive Image
Clear Plastic With Black Ridges	Negative Image	No Image	Negative Image
Clear Plastic With White Ridges	All Areas Light Or Faint Negative	Positive Image	Faint Positive Image Bright Background
Rubber Stamp	Negative Image	No Image Or Faint Positive	Faint Negative

Table 1. Scan results.

As shown by the scan results listed in Table **1**, none of the false image techniques typically produce the same scan result as a real finger with

illumination by either or both of the light sources. The scan results listed in Table 1 describe one or more threshold conditions, which if met by a combination of one or more images from different illumination sources, allows the accurate determination of a real fingerprint. Therefore, the system described above can distinguish a real finger from a reproduction of a fingerprint by the unique scan results generated from different light sources.

The results listed in Table 1 are simplified. The results in Table 1, although typical, are only an example for one embodiment of the disclosed technology. It will be recognized by one of ordinary skill in the art that different embodiments of the disclosed technology may modulate of the intensity of the two light sources or vary the gain or integration time of the two images to achieve an optimum level of canceling or contrast. Such adjustments may be made based on the actual implementation, during testing.

Although the entire fingerprint is typically illuminated when capturing and storing the fingerprint image, for one embodiment, an authenticity check may be performed on a small sample area of the fingerprint instead of the entire fingerprint. Either the first illumination source **105**, **205** or the second illumination source **107**, **207** may optionally selectively illuminate only a portion of the fingerprint. Further, only a small portion of the scanned area is necessary to determine the authenticity of a fingerprint image, which can greatly reduce the computational requirements and/or optical or mechanical complexity of the system. In one embodiment, the total scan area has dimensions of approximately 300 x 400 pixels with a resolution of approximately 350 dots per inch (dpi). A vertical stripe of pixels with dimensions of approximately 255 x 1 may optionally be considered in place of the entire image. The vertical stripe is preferably taken from approximately the middle of the image.

In one embodiment, the authenticity of a fingerprint image is determined by first illuminating the finger with the direct light source **105**, **205** and capturing a first image with the imaging device **113**, **213**. The finger is then illuminated with the TIR light source **107**, **207** and a second image is captured with the

imaging device **113, 213**. A difference between the first and second images is calculated by subtracting the second image from the first image on a pixel by pixel basis. Alternatively, a difference can be calculated by subtracting a portion of the second image from the same portion of the first image, which is typically a vertical stripe taken from the middle of the images. A determination is made that the fingerprint is from a human finger if the ridge amplitude of the difference image is greater than a ridge amplitude of either the first image or the second image.

In another embodiment, the authenticity of a fingerprint image is determined by simultaneously illuminating the finger with the direct light source **105, 205** and the TIR light source **107, 207**. A determination is made that the fingerprint is from a human finger if the difference between a light intensity of a ridge of the fingerprint and a light intensity of a valley of a fingerprint is less than a contrast threshold value or less than the corresponding difference under only TIR or direct illumination.

In another embodiment, the authenticity of a fingerprint image is determined by first illuminating the finger with the direct light source **105, 205** and capturing a first image with the imaging device **113, 213**. The finger is then illuminated with the TIR light source **107, 207** and a second image is captured with the imaging device **113, 213**. A determination is made that the fingerprint is from a human finger if a difference between a peak amplitude of the first image and a peak amplitude of the second image is greater than an amplitude threshold value.

It is well-known that the fingerprint ridges on a human finger tend to flatten out when pressure is applied to the finger, as shown in FIG. 3. At time t0, no pressure is being applied to the finger, and the width of the ridges is represented by u1, u2, u3, u4. At time t1, moderate pressure is being applied to the finger, and the width of the ridges is represented by v1, v2, v3, v4. At time t2, heavy pressure is being applied to the finger, and the width of the ridges is represented by w1, w2, w3, w4.

The system measures the change in fingerprint ridge width, and the time-varying characteristic of the change, when a finger is placed on the platen 103, 203. The finger may be sequentially illuminated by one or more light sources, and the resulting captured images compared to determine the amount of any ridge widening. A determination is made that the fingerprint is from a human finger if the difference between the width of a ridge on the first image and the width of the ridge on the second image is greater than a widening threshold value.

Because the shape of a human finger is generally round, the area of contact tends to increase as the finger is placed on a flat surface, as shown in FIG. 4. At time t0, when relatively little pressure is being applied to the finger, and the area of contact is generally small. As more pressure is applied to the finger, over time the area of contact increases as shown at times t1 through t3. For one embodiment, the system measures the change in the area of contact of the finger, and the time-varying characteristic of the change, when a finger is placed on the platen 103, 203. The finger may be sequentially illuminated by one or more light sources, and the resulting captured images compared to determine the change in the area of contact of the finger. A determination is made that the fingerprint is from a human finger if the difference between the area of contact of an image and the area of contact of subsequent image(s) is greater than a threshold value.

It is well-known that the living skin on a human finger tends to change color, from pink to white, when pressure is applied to the finger. The system, for one embodiment, measures the change in fingerprint color, and the time-varying characteristic of the change, when a finger is placed on the platen 103, 203. The finger may be sequentially illuminated by light sources of two or more different colors, such as red and green or blue, and the resulting captured images compared to determine the amount of any color change. A determination is made that the fingerprint is from a human finger if the color difference between the captured images is greater than a color threshold value.

Alternatively, a broad band or uniform spectrum light source may illuminate the finger and a comparison made between images captured with two or more imaging devices each having different color filters. Alternatively, a single imaging device with two or more filters can capture images of the fingerprint over time and compare the difference in the images to determine the amount of any color change. Alternatively, a single imaging device can capture images of the fingerprint over time and compare the gray-scale difference in the images to determine the amount of any gray-scale or color change. Alternatively, as shown in FIG. 5, a portion of the platen **501** can be modified so that some areas are raised and/or some areas are depressed. The platen **501** may have a raised or depressed area in the shape of a square or windowpane **503**, a curve **505**, or another shape. The raised areas **503**, **505** of the platen **501** will show more and/or faster whitening of the finger than the depressed areas because there is more pressure on the skin of the finger in the raised areas. The raised or depressed areas may optionally be in the active area of the fingerprint, which is the area which is captured and analyzed for features. For one embodiment, the system tracks the area of the finger that has the raised area. Because the relative positioning of the finger differs for each use of the sensor, this may be an additional safety device.

FIG. **6** shows a method of distinguishing a human finger from a reproduction of a fingerprint. At step **601**, the finger is illuminated with a direct or orthogonal light source. At step **603**, a first image of the fingerprint is captured. At step **605**, the finger is illuminated with an acute light source. At step **607**, a second image of the fingerprint is captured. At step **609**, the first image is compared to the second image. If at **611** the sum of a difference is greater than a sum threshold, at **613** a determination is made that the fingerprint is from a human.

FIG. **9** shows a method of distinguishing a human finger from a reproduction of a fingerprint using TIR compatible with the disclosed technology. At step **901**, the light output, gain, and offset settings are calibrated

for TIR and direct illumination conditions. At 903, using TIR, the image is analyzed to determine if there is high contrast between the fingerprint ridges. If not, at step 905 a delay is introduced, and control returns to 903. Otherwise, at step 907 a TIR image is captured and stored in a memory. At step 909, a ridge amplitude is calculated for the TIR image. For one embodiment, the TIR image is filtered and the root mean square (RMS) or equivalent value of the ridge amplitude is calculated. This value is known as score 1. At step 911, a direct illumination image is captured.

At step 913, the TIR image is subtracted from the direct illumination image. For one embodiment, this is implemented by, on a pixel-by-pixel basis, inverting the TIR value in memory and adding it to the direct illumination pixel value. At step 915, the resulting image data is filtered and the RMS or equivalent value is computed for the ridge amplitude. This value is known as score 2. At step 917, the scores are compared. If at 917 score 2 is greater than score 1, at step 921 a determination is made that the fingerprint is from a human. Otherwise, at step 919 a determination is made that the fingerprint is not from a human.

While the invention is described in terms of exemplary embodiments in a specific system environment, those of ordinary skill in the art will recognize that the invention can be practiced, with modification, in other and different hardware and software environments within the spirit and scope of the appended claims.

CLAIMS

What is claimed is:

1. A method for determining if a fingerprint is from a human finger placed on a platen, the method comprising:

illuminating the finger;

capturing with an imaging device a first image of the fingerprint at a first time instant;

capturing with the imaging device a second image of the fingerprint at a second time instant;

comparing the first image to the second image; and

determining that the fingerprint is from a human finger if the difference between the color of the first image and the color of the second image is greater than a color threshold value.

2. The method of claim 1, wherein the light source comprises a substantially red light source.

3. The method of claim 1, wherein the light source comprises a substantially green light source.

4. The method of claim 1, wherein the light source comprises a substantially blue light source.

5. The method of claim 1, wherein the light source comprises a substantially white light, and the imaging device is a color imaging device.

6. The method of claim 1, wherein the platen comprises a platen having a raised portion.

7. The method of claim 6, wherein the step of determining that the fingerprint is from a human finger comprises determining if the difference between the color in the raised portion of the first image and the color in the raised portion of the second image is greater than a color threshold value.

8. A method for determining if a fingerprint is from a human finger placed on a platen, the method comprising:

capturing a first image of the fingerprint illuminated with a first light source;

capturing a second image of the fingerprint illuminated with a second light source;

determining a first ratio of the first image and the second image;

capturing a third image of the fingerprint illuminated with the first light source;

capturing a fourth image of the fingerprint illuminated with the second light source;

determining a second ratio of the third image and the fourth image; and

determining that the fingerprint is from a human finger if the difference between the first ratio and the second ratio indicates an appropriate color change of the fingerprint over time.

9. The method of claim 8, wherein the light source comprises a substantially red light source.

10. The method of claim 8, wherein the light source comprises a substantially green light source.

11. The method of claim 8, wherein the light source comprises a substantially blue light source.

12. The method of claim 8, wherein the light source comprises a substantially white light source, and the imaging device is a color imaging device.

13. The method of claim 8, wherein the platen comprises a platen having a raised portion.

14. The method of claim 13, wherein the step of determining that the fingerprint is from a human finger comprises determining if the difference between the color in the raised portion of the first image and the color in the raised portion of the second image is greater than a color threshold value.

15. An apparatus for scanning a fingerprint and determining if the fingerprint is a live finger, the apparatus comprising:

a transparent platen;

a light source for directing light to illuminate a finger placed on the platen;

an electronic imaging device positioned to capture a plurality of images of the fingerprint; and

logic to determine a color change in the fingerprint, the logic determining if the fingerprint is a live finger based on the color change.

16. The apparatus of claim 15, wherein the logic comprises:

a memory for storing the plurality of images;

a ratio unit for calculating a ratio of the images; and

a determination unit for determining whether the ratio is above a threshold to indicate that the finger is a live finger.

17. The apparatus of claim 15, wherein the light source comprises a white light source.

18. The apparatus of claim 15, wherein the light source comprises one or more of the following light sources: a red light, a green light, and a blue light.

19. The apparatus of claim 18, wherein a first image is captured using one of the light sources, and the second image is captured using another of the light sources.

20. The apparatus of claim 19, wherein subsequent images are captured with a same light sources, to determine color change of the fingerprint over time.

21. The apparatus of claim 15, further comprising:

a raised area on the platen, the raised area used to determine whether a portion of the fingerprint on the raised area changes color at a different rate than a portion of the fingerprint not on the raised area.

22. A method of capturing a fingerprint image and determining whether the fingerprint image is from a live finger on a platen, the method comprising:

capturing a first image of a fingerprint;

capturing a second image of a fingerprint;

determining whether a color of the fingerprint changes from pink to white over time, as would a color of a live finger.

23. The method of claim 22, further comprising:

detecting a portion of the fingerprint on a raised area on the platen;

determining whether the color of the portion of the fingerprint on the raised area on the platen changes color at a different rate than the portion of the fingerprint not on the raised area; and

determining whether the finger is a live finger based on the comparative rates of change.

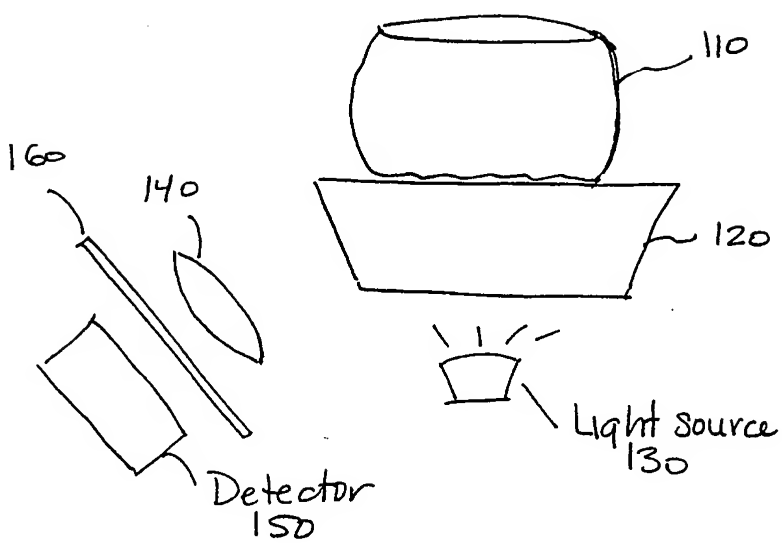


FIG. 1

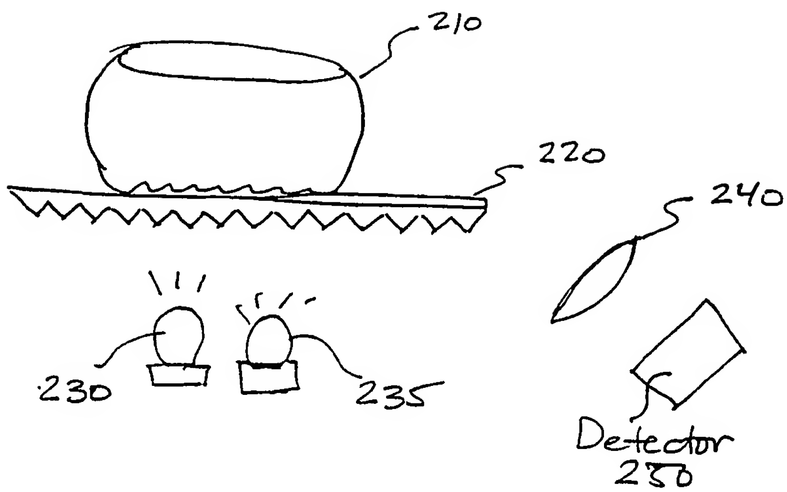


FIG. 2

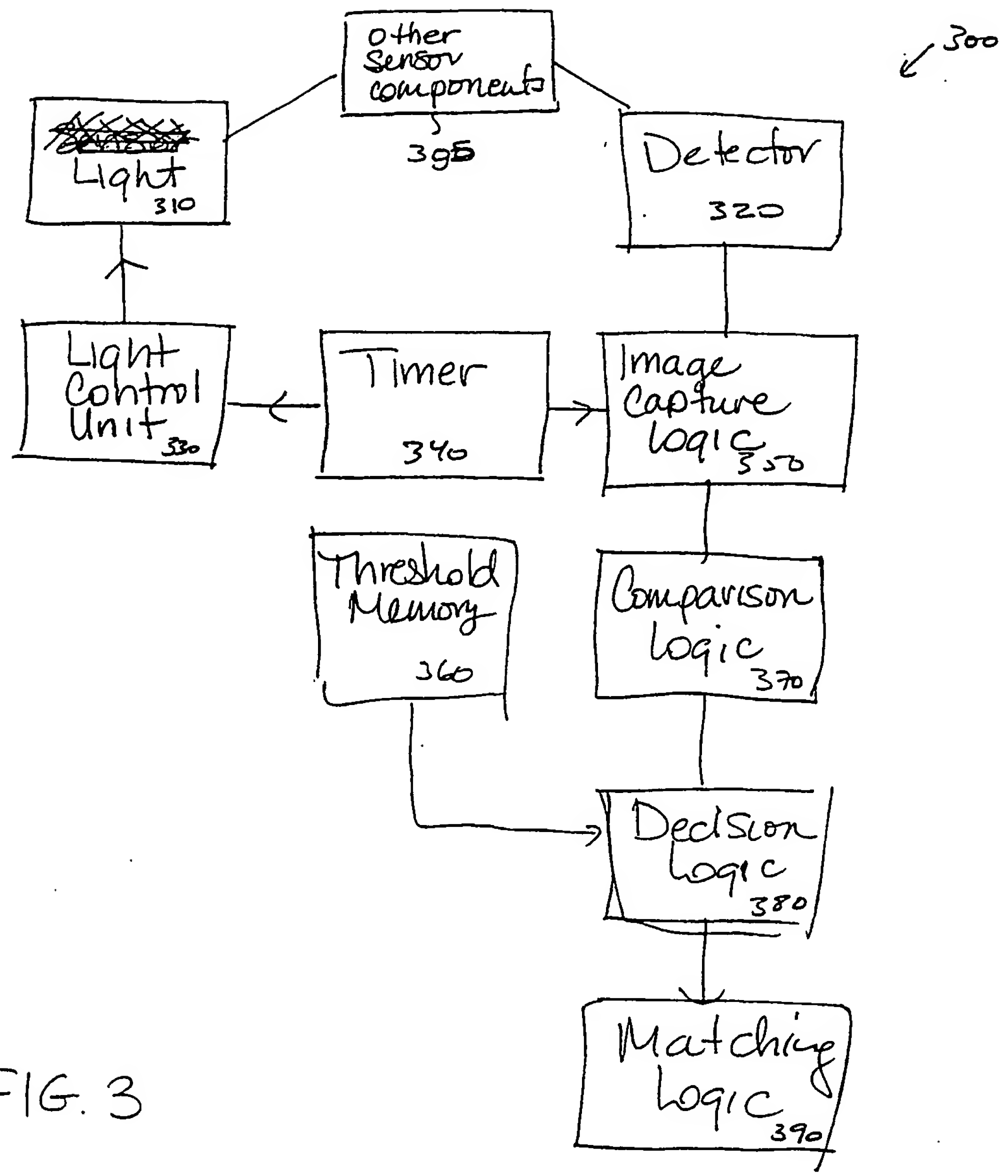

300
Other Sensor components
395
Light
310
Detector
320
Light Control Unit
330
Timer
340
Image Capture logic
350
Threshold Memory
360
Comparison logic
370
Decision logic
380
Matching logic
390

FIG. 3

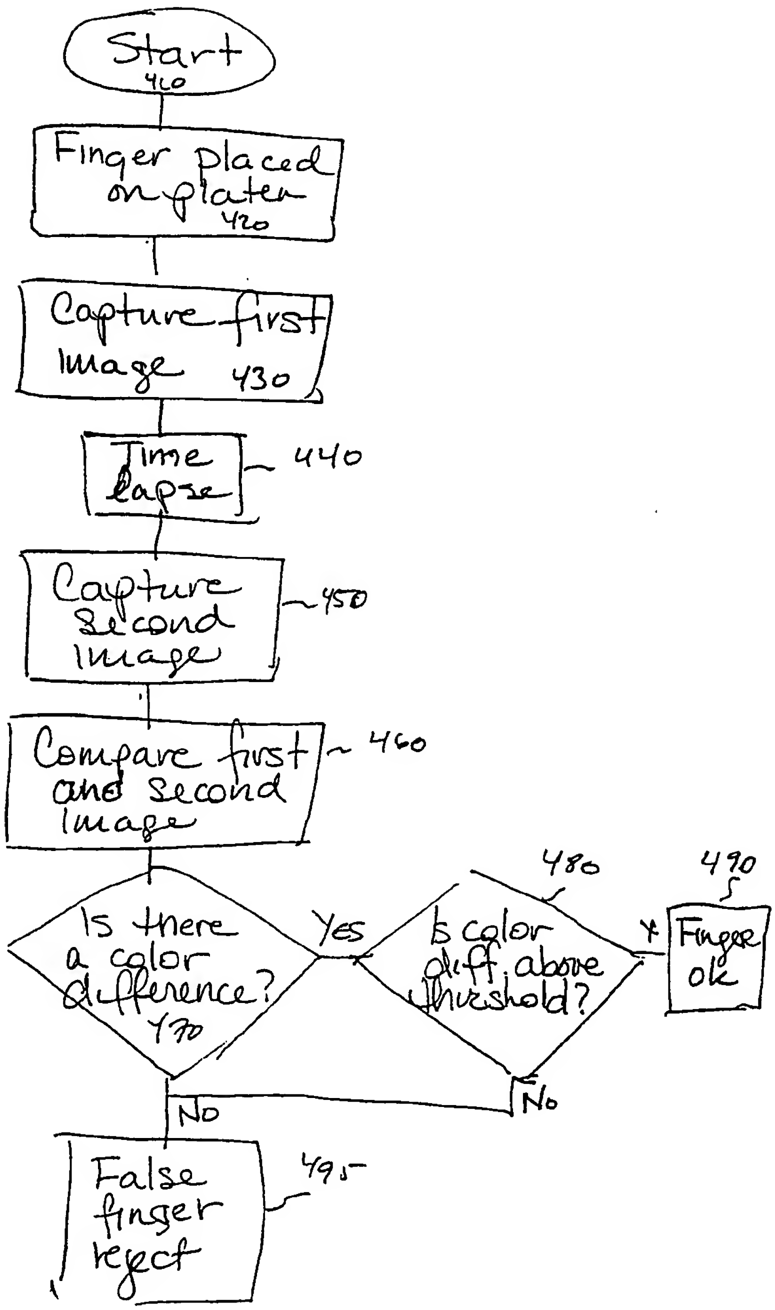

Start
410
Finger placed on platen
420
Capture first image
430
Time lapse
440
Capture second image
450
Compare first and second image
460
Is there a color difference?
470
Yes
Is color diff above threshold?
480
Y
Finger ok
490
No
No
False finger reject
495

FIG. 4

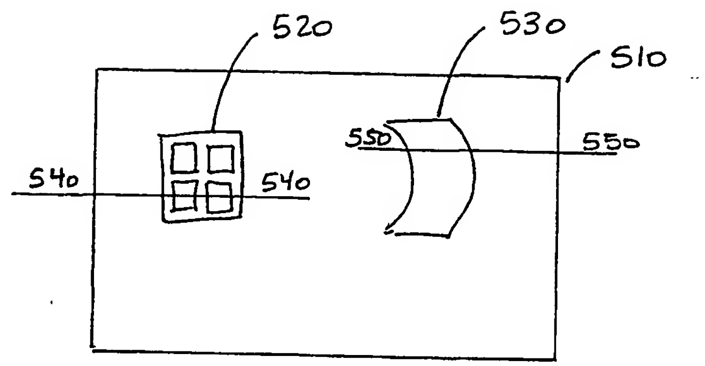


FIG. 5A

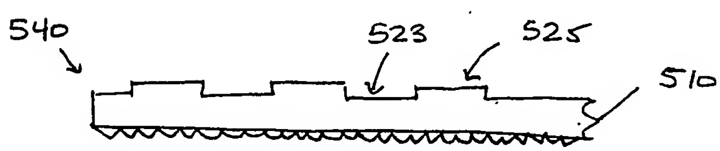


FIG. 5B

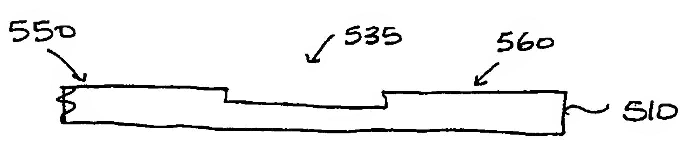


FIG. 5C

THIS PAGE BLANK (USPTO)

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
7 September 2001 (07.09.2001)

PCT

(10) International Publication Number
WO 01/65466 A3

(51) International Patent Classification[7]: G06K 9/00

(21) International Application Number: PCT/US01/06711

(22) International Filing Date: 28 February 2001 (28.02.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
09/515,249 29 February 2000 (29.02.2000) US

(71) Applicant (*for all designated States except US*): **DIGITAL PERSONA, INC.** [US/US]; Suite 226, 805 Veterans Boulevard, Redwood City, CA 94063 (US).

(72) Inventors; and
(75) Inventors/Applicants (*for US only*): **BROWNLEE, Kenneth** [US/US]; 3617 Louis Road, Palo Alto, CA 94303 (US). **MOK, Fai** [US/US]; 24230 Hillhurst Drive, West Hills, CA 91304 (US).

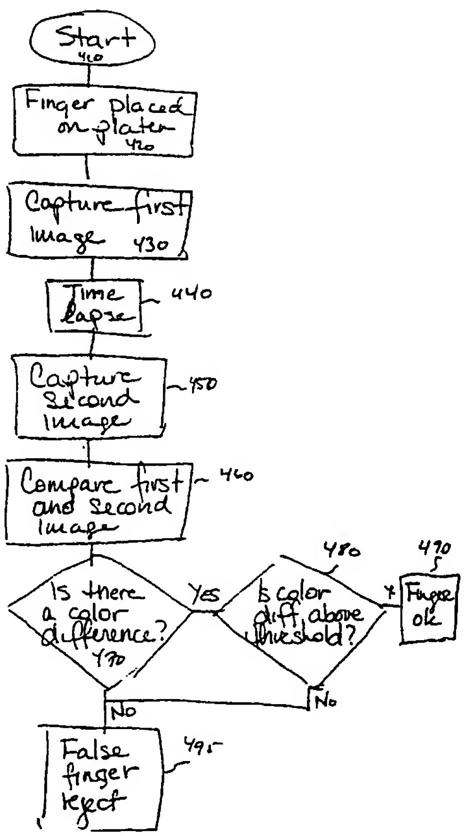
(74) Agents: **MALLIE, Michael, J.** et al.; Blakely, Sokoloff, Taylor & Zafman LLP, 7th floor, 12400 Wilshire Boulevard, Los Angeles, CA 90025 (US).

(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: METHOD AND APPARATUS FOR DETECTING A COLOR CHANGE OF A LIVE FINGER



(57) Abstract: A method and apparatus for distinguishing a human finger from a reproduction of a fingerprint. A finger (fig. 1, 110) is placed on a transparent platen (fig. 120) having a prism or microprism array attached. A first light source (fig. 1, 130) directs light substantially orthogonal to the platen, where a first image of the fingerprint is captured by an imaging device. A second light source directs light at an acute angle to the platen, where a second image of the fingerprint is captured by the imaging device. A determination that the fingerprint is from a human finger is made if a mathematical comparison (fig. 3, 370) of the two images meets some predetermined criteria.

WO 01/65466 A3

Published:
— *with international search report*

(88) Date of publication of the international search report: 20 December 2001

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US01/06711

A. CLASSIFICATION OF SUBJECT MATTER	
IPC(7) : G06K 9/00 US CL : 382/124, 126, 127, 162,167. According to International Patent Classification (IPC) or to both national classification and IPC	
B. FIELDS SEARCHED	
Minimum documentation searched (classification system followed by classification symbols) U.S. : 382/124, 126, 127, 162,167.	
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched	
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) BRS	

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,623,553 A (SEKIYA) 22 April 1997, abstract, col. 1, lines 45 - 67 .	1-23
Y	US 5,040,223 A (KAMIYA et al) 13 August 1991, abstract, col. 3, lines 15 - 68, col. 4, lines 1 - 58	1-23

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date		
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed	"&"	document member of the same patent family

Date of the actual completion of the international search 19 MAY 2001	Date of mailing of the international search report 10 SEP 2001
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer SHEELA CHAWAN Telephone No. (703) 305-4876